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Oceanographic conditions in the Estuary and the Gulf of St. Lawrence during 2002 : zooplankton.

Conditions océanographiques dans l'estuaire et le golf du Saint-Laurent en 2002 : zooplancton.

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ABSTRACT

Zooplankton biomass, abundance, and species composition in the Québec region (Lower St. Lawrence Estuary and Gulf of St. Lawrence) during 2002 are reviewed and related to conditions during the preceding year and over the longer-term where applicable. In addition, this report gives an overview of the interannual variability of the mesozooplankton biomass and the macrozooplankton species composition, abundance, and biomass in the Lower Estuary and the northwest Gulf of St. Lawrence as measured in September in each year between 1994 and 2002.

The zooplankton biomass and abundance in the Québec fixed stations in 2002 were comparable to conditions observed in previous years except in the Gaspé current were the mean integrated zooplankton biomass was 1.5 times higher in 2002 than in 2001 and 2000. Copepod eggs, juveniles, and adults were clearly dominant, accounting for more than 80% of the zooplankton community for all sampling dates in the Anticosti Gyre and the Gaspé Current. The depth-integrated abundance of the stage composition of *Calanus finmarchicus* showed that in 2002 there was two periods of reproduction for this species in both stations. The first and the second period of reproduction occurred in summer (June-July) and fall (September-October) respectively and were synchronized in both stations. The same situation was observed in 2001 and 2000.

The zooplankton biomasses observed in spring and fall 2002 along the six AZMP sections were comparable with observations made in 2001 and 2000. The zooplankton abundance was higher than in 2001 in both the LSLE and the Gulf of St. Lawrence but comparable to the levels observed in 2000.

The mesozooplankton biomass in the Lower Estuary and the northwest Gulf of St. Lawrence in 2002 was slightly higher than in 2001 while the macrozooplankton biomass was comparable to the level of 2001. The year 2002 was characterized by a significant increase of the mean abundance the chaetognath *Sagitta elegans*, the gelatinous zooplankton *Aglantha digitale*, *Obelia* sp., and *Boreo* sp., and the pelagic amphipod *Themisto abyssorum* and a significant decrease of the mean abundance of the mysid *Boreomysis arctica*.

RÉSUMÉ

L'information présentée dans ce rapport décrit l'état du zooplancton dans le Saint-Laurent en 2002. Ces résultats proviennent de l'analyse des données de deux stations fixes situées dans la gyre d'Anticosti et le courant de Gaspé et de six sections réparties dans l'ensemble de l'estuaire maritime et du golfe du Saint-Laurent. Des informations additionnelles provenant d'une grille de 48 stations échantillonnées depuis 1994 dans l'estuaire maritime et le golfe du Saint-Laurent sont aussi présentées. Nous mettons l'accent sur les conditions en 2002, que nous comparons ensuite aux observations recueillies en 1999, 2000 et 2001 dans le cadre du programme de monitorage de la zone Atlantique (PMZA) et aux observations sur le macrozooplancton recueillies de 1994 à 2002.

Dans la gyre d'Anticosti et le courrant de Gaspé, l'abondance moyenne et la biomasse de zooplancton observée en 2002 correspondent aux niveaux observés en 1999, 2000 et 2001 à l'exception de la biomasse dans le courant de Gaspé qui était 1.5 fois plus élevée qu'au cours des années précédentes. Les copépodes (œufs, juvéniles et adultes) étaient clairement les organismes dominants, constituant plus de 80 % de la communauté de zooplancton à toutes les dates d'échantillonnage dans la gyre d'Anticosti et le courant de Gaspé. Aux deux stations, l'espèce de copépode *Calanus finmarchicus* s'est reproduit à deux reprises pendant l'été 2002. La première période de reproduction s'est produite en juin-juillet et la seconde en septembre-octobre. Cette situation est semblable à celle observée en 2001 et 2000. De façon générale, les biomasses de zooplancton observées au printemps et à l'automne 2002 aux différentes stations de l'estuaire maritime et du golfe du Saint-Laurent étaient comparables à celles observées en 2000 et 2001 dans les mêmes régions. Cependant, les abondances de zooplancton observées en 2002 étaient plus élevées qu'en 2001, mais comparables à celles observées en 2000.

Les résultats obtenus aux stations situées le long des six sections du PMZA montrent qu'au printemps et à l'automne 2002 les biomasses de zooplancton étaient semblables à celles observées en 2001 et 2000 aux même stations. Par contre, l'abondance de zooplancton était plus élevée qu'en 2001 mais comparable à 2000.

Dans l'estuaire maritime et le Nord-Ouest du golfe, la biomasse de mésozooplancton a légèrement augmenté en 2002 en comparaison avec 2001 alors que la biomasse de macrozooplancton n'a pas varié de façon significative. Des changements importants dans l'abondance moyenne de certaines espèces de macrozooplancton ont cependant été observées. Nous avons observé une diminution significative de l'abondance moyenne du mysidacé *Boreomysis arctica* et une augmentation significative de l'abondance du chaetognath *Sagitta elegans*, de certaines espèces gélatineuses (*Aglantha digitale*, *Obelia* sp. et *Boreo* sp.) ainsi que de l'amphipode pélagique *Themisto abyssorum*.

INTRODUCTION

The Atlantic Zonal Monitoring Program (AZMP) was implemented in 1998 (Therriault et al. 1998) with the aim of: (1) increasing DFO's capacity to understand, describe, and forecast the state of the marine ecosystem and (2) quantifying the changes in ocean physical, chemical and biological properties and the predator-prey relationships of marine resources. A critical element in the observational program of AZMP is an annual assessment of the distribution and variability of nutrients and the plankton they support.

A description of the distribution in time and space of nutrients dissolved in seawater (nitrate, silicate, phosphate, oxygen) provides important information on the water-mass movements and on the locations, timing and magnitude of biological production cycles. A description of the distribution of phytoplankton and zooplankton provides important information on the organisms forming the base of the marine foodweb. An understanding of the production cycles of plankton is an essential part of an ecosystem approach to fisheries management.

The AZMP derives its information on the state of the marine ecosystem from data collected at a network of sampling locations (fixed point stations, sections, groundfish surveys) in each region (Québec, Maritimes/Gulf, Newfoundland) sampled at a frequency of bi-weekly to once annually. Furthermore, in the Québec region we have a zooplankton biomass survey, which is carried out in the lower Estuary and the northwest Gulf of St. Lawrence in September since 1994. The sampling design provides basic information on the natural variability in physical, chemical and biological properties of the Northwest Atlantic continental shelf and the Gulf of St. Lawrence. The annual zooplankton biomass survey and sections provide detailed geographic information but are limited in their seasonal coverage. Critically placed fixed stations complement the geography-based sampling by providing more detailed information on temporal (seasonal) changes in ecosystem properties.

The purpose of this document is to provide an overview of the temporal variability in 2002 of the zooplankton biomass, abundance, and species composition at two fixed stations (Anticosti Gyre and Gaspé Current) and six sections (St. Lawrence Estuary, Sept-Îles, Bonne Bay, Anticosti, Cabot Strait, Magdalen Island) of the AZMP as well as an overview of the interannual variability of the macrozooplankton species composition, abundance, and biomass in the Lower St. Lawrence Estuary and the northwest Gulf of St. Lawrence from 1994 to 2002.

SPATIAL AND TEMPORAL VARIABILITY OF ZOOPLANKTON SPECIES COMPOSITION, ABUNDANCE, AND BIOMASS AT TWO FIXED STATIONS AND SIX TRANSECTS OF THE AZMP IN 2002

Material and Methods

The sampling dates at the fixed stations (Anticosti Gyre and Gaspé Current) and along the sections (St. Lawrence Estuary, Sept-Îles, Bonne Bay, Anticosti, Cabot Strait, Magdalen Island) are given in Figure 1. In 2002, zooplankton samples were collected during 18 visits to the fixed stations and two visits to the sections. Collections and standard measurements of zooplankton biomass and abundance are based on protocols outlined by the Steering Committee of the Atlantic Zonal Monitoring Program (AZMP)[1].

[1] Mitchell, M. (ed). 2002. Atlantic Zonal Monitoring Program: Sampling Protocol. Can. Tech. Rep. Hydrogr. Ocean Sci. 223, 23 pp

We analyzed the monthly variations of a series of indices describing the state of the zooplankton community at each station in 2002. The indices are: 1) the depth-integrated biomass of both the macrozooplankton and the mesozooplankton, 2) the depth-integrated zooplankton abundance and community structure, 3) the depth-integrated copepod abundance and community structure, 4) the depth-integrated abundance of the stage composition of *Calanus finmarchicus* copepodites.

Results and discussion

Fixed stations. In 2002, the zooplankton biomass varied between 67 and 204 g ww · m^{-2} at the Anticosti Gyre (AG) station and between 21 and 123 g ww · m^{-2} at the Gaspé Current station (Figure 2). The maximum and the minimum biomasses occurred in March and April respectively at the AG station while the minimum and the maximum biomasses were observed in December and April respectively in the Gaspé Current (GC). The annual minimum (AG) and maximum (GC) zooplankton biomasses occurring in April seem to be typical since the same situation was observed in 1999, 2000, and 2001 (Figure 2). The mean biomass for 2002 was 3.0 times higher in the AG (151.4 g ww · m^{-2}) than in the GC (51.3 g ww · m^{-2}). The higher biomass at the AG station was largely due to the higher abundance of *Calanus hyperboreus*. The mean integrated zooplankton biomass in the AG was comparable with observations made in 1999, 2000, and 2001 while in the GC the mean integrated zooplankton biomass was 1.5 times higher than in 2001 and 2000 (Figure 3).

The total abundance of zooplankton in 2002 varied between 49,161 and 241,525 individuals · m^{-2} in the AG and between 16,980 and 239,966 individuals · m^{-2} in the GC. At both stations, the total abundance of zooplankton observed in 2002 was comparable with observations made in 2000 and 2001 (Figure 4). Copepod eggs, juveniles, and adults were clearly dominant, accounting for more than 80% of the zooplankton community for all sampling dates in the AG and the GC (Figure 4). The same situation was observed in 2001 at both stations, but not in 2000, while the others zooplankters represented more than 50% of the zooplankton assemblage in spring and summer in the AG and in summer in the GC. In the AG, the ostracoda were present at all sampling dates and accounted for ca. 10% of the zooplankton assemblage from April to July. In July and August, the larvacea accounted for 10% of the zooplankton assemblage in both stations. All others zooplankters (mollusk larvae, euphausiids, jellies, chaetognaths, polycheates) represented less than 5% of the zooplankton community for all sampling dates at both stations. They mostly occurred during the summer season at both stations.

In 2002, the total abundance of copepods integrated over the water column varied between 34,632 and 213,315 individual · m^{-2} in the AG and between 15,534 and 221,373 individuals · m^{-2} in the GC (Figure 5). These values are comparable with observations made in 2001 and 2000 at both stations. In the GC, the minimum and the maximum copepod abundances occurred in June and late October respectively and were synchronized with the minimum and the maximum values observed in 2001; the maximum and the minimum copepod abundances were observed in April and June in the AG (Figure 5). This maximum in April is not usual for this station and was due to the high abundance of Calanoid nauplii that represented more than 60% of the copepod assemblage in the AG in April. Close examination of the monthly variations of the copepod community structure reveals that large copepod species (*Calanus finmarchicus* and *C. hyperboreus*) were dominant for all sampling dates in the AG except in summer, when *Eucheata norvegica* and *Metridia* spp. were more abundant, and in Fall, when the small species *Oithona similis* was more abundant (Figure 5). On the other hand, the small copepod *Oithona similis* was dominant for all sampling dates in the GC except in July, when larger species such as *Calanus finmarchicus* and *C. hyperboreus* were more abundant (Figure 5). The same situation was observed in 2001 and 2000 at both stations.

Finally, the depth-integrated abundance of the stage composition of *Calanus finmarchicus* in 2002 showed two periods of reproduction for this species at both stations. Based on the

increased occurrence of the copepodites stages CI, CII, CII, and CIV, the first and the second period of reproduction occurred in summer (June-July) and fall (September-October) and were synchronized at both stations (Figure 6). The same situation was observed in 2001 and 2000.

Sections. The total zooplankton biomass varied between 0.5 and 213 g ww · m^{-2} along the six transects sampled in June and November 2002 in the lower Estuary and the Gulf of St. Lawrence (Figure 7). The biomass increased with the depth along all transects during the two sampling periods. The highest biomasses were found along the four transects located over the Laurentian Channel (St. Lawrence Estuary, Sept-Îles, Anticosti, and Cabot Strait) and the lowest biomass were found in the northern (Bonne Bay) and the southern (Magdalen Island) regions. The zooplankton biomass was higher in November than in June along all transects except at the shallow stations on both ends of each transect, and in the southern (Magdalen Island) region where the inverse was true (Figure 7). The zooplankton biomasses observed in 2002 along all transects at both seasons was comparable with observations made in 2001 and 2000 (Figure 8).

The overall abundance of zooplankton varied between 1,928 and 234,410 ind. m^{-2} for all transects in June and between 4,133 and 665,081 ind. m^{-2} in November 2002. The highest abundances of zooplankton were observed along the Magdalen Island, Bonne Bay and Cabot Strait transects in fall (Figure 9). Juvenile and adult copepods were clearly dominant along all transects, accounting for an average of 85% and 91% of the assemblage in June and November respectively (Figure 9). All other zooplankters (copepods eggs, invertebrate larvae, larvacea, mollusk larvae, ostracods, euphausiids, gelatinous zooplankton, and cheatognaths) represented less than 35% of the zooplankton community in all regions in June and November (figure 9). The overall abundance of copepods integrated over the water column varied between 1,240 and 224,093 ind. m^{-2} along all transects in June and between 4,088 and 644,650 ind. m^{-2} in November (Figure 10). A closer examination of the abundance and the spatial distribution of the most important copepod species showed different patterns of distribution in the lower Estuary and the Gulf of St. Lawrence (Figure 10). In June, a group composed of large copepod species (*Calanus finmarchicus*, *C. hyperboreus*, *Metridia longa*) dominated in abundance in all regions. In November, the small species *Oithona* spp. dominated in abundance in all regions except in the St. Lawrence estuary where the large copepod species (*Calanus finmarchicus*, *C. hyperboreus*, *Metridia longa*) were more abundant (Figure 10).

Contrary to the situation observed in 2001 where the overall abundance of zooplankton was generally lower than in 2000 in all regions for both seasons except in fall in the southern Gulf (Magdalen Island transect), in 2002 the overall abundance of zooplankton increased to the levels observed in 2000 in all regions seasons except in fall in the southern Gulf (Magdalen Island transect) where the abundance continue to increase as compared to 2000 and 2001 (Figure 11).

INTERANNUAL VARIATIONS OF THE MACROZOOPLANKTON SPECIES COMPOSITION, ABUNDANCE, AND BIOMASS IN THE LOWER ST. LAWRENCE ESTUARY AND THE NORTHWEST GULF OF ST. LAWRENCE FROM 1994 TO 2001

Material and Methods

The survey involves sampling with a 1 m^2 BIONESS plankton net equipped with 333-µm mesh nets at each of up to 44 stations along eight transects covering the lower Estuary and the northwest Gulf of St. Lawrence from Les Escoumins to Sept-Îles (Figure 12). In 1994, only transects K through T were surveyed. Transects G and I, at the head of the Laurentian Channel, have been sampled in since 1995 whereas transect U in the AG has only been sampled since 1997. The survey has taken place in September of each year, usually during a period of 10 days in the middle of the month. At each station, the water column was sampled twice, each time with two nets (bottom-150m and 150-0m or bottom-0 for stations < 150 m depth). Approximately half

the stations were sampled in day and half at night. The total zooplankton wet weight and the wet weights of fish (the Atlantic soft pout, *Melanostigma atlanticum*), pandalid shrimp, and gelatinous zooplankton, were measured on board immediately after the tow. Since 1998, larger samples have been split on board with a Folsom plankton splitter to obtain a maximum volume of 125 ml. The catch was then preserved and the following categories (sorted manually) were analyzed for wet weight upon return to the laboratory:

- **Macrozooplankton**: adult and juvenile euphausids (*Meganyctiphanes norvegica, Thysanoessa inermis* and *T. raschii*). This category also includes mysids, which were commonly found in deep samples, and hyperiid amphipods.

- **Mesozooplankton**: predominantly copepods, but also other mesozooplankton, including chaetognaths and benthic invertebrate larvae. Excludes gelatinous zooplankton, decapods, and macrozooplankton (as defined above).

One replicate per station per year was thereafter analyzed to determine the species composition and the abundance of the macrozooplankton (adult size > 1 cm). Wet weights and species abundance for each tow were divided by volume filtered (m^3) as measured by a General Oceanic flow meter installed in the mouth of the BIONESS. . Integrated biomass and abundance for the water column (t ww · km^{-2}) was calculated by multiplying the standardized wet weight and abundance by the depth interval sampled by the net.

Results and discussion

The total mesozooplankton biomass observed in September 2002 in the Lower St. Lawrence Estuary and in the northwest GSL is slightly higher than the September 1995, 1996, 2000, and 2001 observations, comparable to the September 1997, 1998 and 1999 measurements, and 1.6 times lower than in September 1994 (Figure 13). Likewise, the total macrozooplankton biomass observed in September 2002 is comparable to the 1996 1998, 1999, 2000, and 2001 measurements, slightly lower than the September 1997, observations, and 3.1 and 3.3 times lower than in September 1995 and 1994 respectively.

On the other hand, the relative abundance of the three most important macrozooplankton groups in terms of biomass (euphausiids, mysids, hyperiid amphipods) varied significantly as a function of the year (Figure 13). The relative abundance of the euphausiids decreased steadily from 87% to 55% between 1994 and 1995 and stays stable to ca. 50% of the macrozooplankton assemblage between 1995 and 2002. The relative abundance of the mysid *Boreomysis artica* increased from 3% in 1994 to 29% in 2000 and decreased again to ca.16% in 2001 and 2002 (Figure 13). Finally, the relative abundance of the hyperiid amphipods increased from 8% in 1994 to 40% in 1995, stayed around 20% from 1996 to 1998, significantly decreased from 23% to 1% between 1998 and 2000, and significantly increased again from 1 to 16% in 2001 and 18% in 2002 (Figure 13).

Figure 14 shows the interannual variation in the total abundance of the various macrozooplankton species belonging to each of the groups previously discussed. From 1994 to 1996, the mean abundance of *Thysanoessa raschii* and *Meganyctiphanes norvegica* decreased from 250 to 40 ind. m^{-2} and from 35 to 5 ind. m^{-2} respectively. The mean abundance of *T. raschii* was stable at ca. 40 ind. m^{-2} from 1996 to 1999 and increased to 50 ind. m^{-2} in 2000. From 2000 to 2002, the mean abundance of *T. raschii* decreased from 46 to 25 ind. m^{-2}. On the other hand, the mean abundance of *M. norvegica* increased from 5 to 22 ind. m^{-2} from 1996 to 1997 and decreased again to 5 m^{-2} in 2000. From 2000 to 2001, the mean abundance of *M. norvegica* increased from 5 to 15 ind. m^{-2} and decreased to 10 ind. m^{-2} in 2002. The mean abundance of the chaetognath *Sagitta elegans* decreased from 22 to 8 ind. m^{-2} between 1994 and 1997, increased to 25 ind. m^{-2} in 1998, and decreased again to ca. 10 ind. m^{-2} in 1999 and 2000. From 2000 to 2002, the mean abundance of *S. elegans* increased significantly from 10 to 35 ind. m^{-2}. The mean abundance of the gelatinous zooplankton (mostly cniderians) varied between 15 and 4 ind. m^{-2} during the time

series with minima observed at the beginning of 1994-95 and the end of 2000-01 and maxima between 1996 and 1999 (Figure 14). Nevertheless, from 2001 to 2002, the mean abundance of the gelatinous zooplankton increased significantly from 6 to 35 ind. m^{-2}. In contrast with all other macrozooplankton species, the mean abundance of the mysid *Boreomysis arctica* was lowest in 1994, 1995, and 1996 (ca. 18 ind. m^{-2}) and increased significantly in 1997, 1998, and 1999 to reach a value that was three times higher in 1999 than in 1996. Since 1999, the mean abundance of *B. artica* has been stable at ca. 60 ind. m^{-2} (Figure 14). In 2002, the mean abundance of B arctica decreased near to the level observed in 1994,1995, and 1996 to ca, 20 ind. m^{-2}. Finally, the mean abundance of the hyperiid amphipod, *Themisto abysorum* decreased from 40 ind. m^{-2} in 1994 to 3 ind. m^{-2} in 1995, slightly increased in 1997 and 1998, and decreased again in 2000 and 2001 to reach 1 ind. m^{-2} in 2001. Likewise, the mean abundance of *Themisto libellula* decreased from 15 to 5 ind. m^{-2} between 1995 and 1996, increased to 10 ind. m^{-2} in 1998, and decreased to 0.17 ind. m^{-2} in 2000. From 2000 to 2001, the mean abundance of *T. libellula* largely increased from 0.17 to 10 ind. m^{-2} (Figure 14). In 2002, the mean abundance of *T. libellula* was similar to one observed in 2001. We hypotheses that this significant increase in the mean abundance of *T. libellula* observed in 2001and 2002 in the lower Estuary and the Gulf of St. Lawrence would be associated with the intrusion of the cold Labrador Current water into the Gulf of St. Lawrence via the Strait of Belle-Isle (Harvey et al. 2002, Starr et al. 2002).

In summary, there was a slight increase in the mesozooplankton biomass in 2002 compared to 2001 and no significant changes in the macrozooplankton biomass. On the other hand, the year 2002 was characterized by a significant increase of the mean abundance the chaetognath *Sagitta elegans*, the gelatinous zooplankton *Aglantha digitale*, *Obelia* sp., and *Boreo* sp., and the pelagic amphipod *Themisto abyssorum* and a significant decrease of the mean abundance of the mysid *Boreomysis arctica*. The mean abundance of the gelatinous zooplankton and *S. elegans* increased from 10 ind. · m^{-2} in 2001 to 35 ind. · m^{-2} in 2002 while the mean abundance of *B. arctica* was tow times lower in 2002 then in 2001. In 2002, the mean abundance of *T. libellula* was similar to one observed in 2001 and the significant relationship between the annual CIL core temperature index and the mean annual abundance of *T. libellula* observed in 2001 is still significant suggesting that the presence and the abundance of this species in the estuary and the gulf of St. Lawrence Lawrence would be associated with the intrusion of the cold Labrador Current water into the Gulf of St. Lawrence via the Strait of Belle-Isle.

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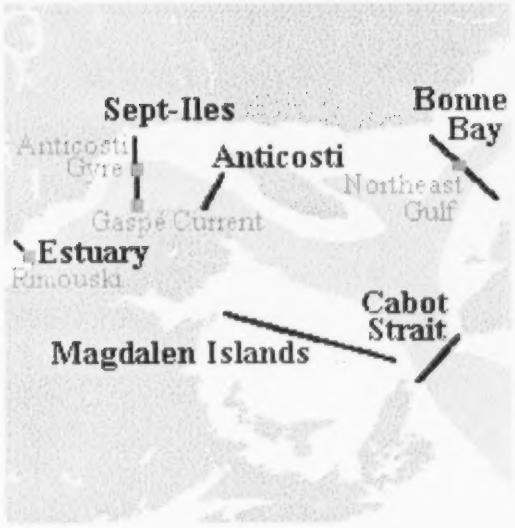


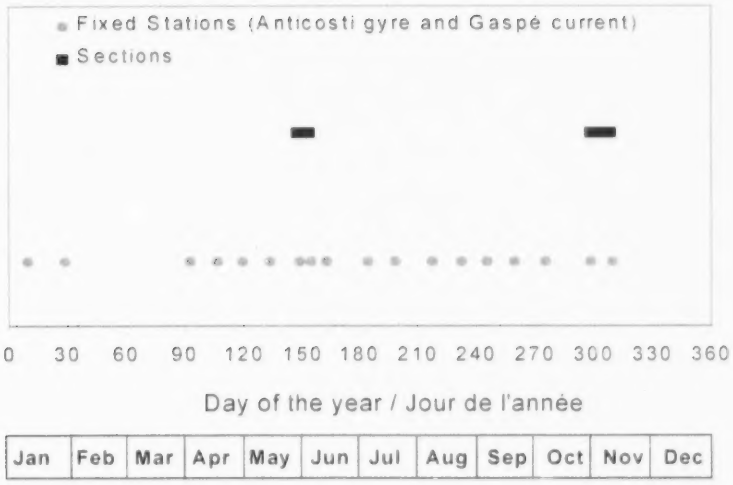
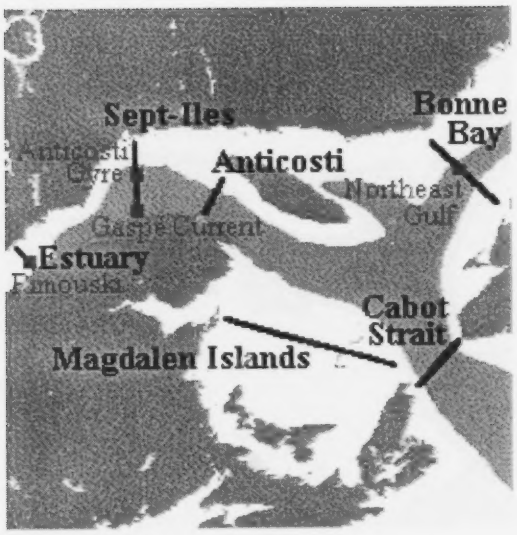
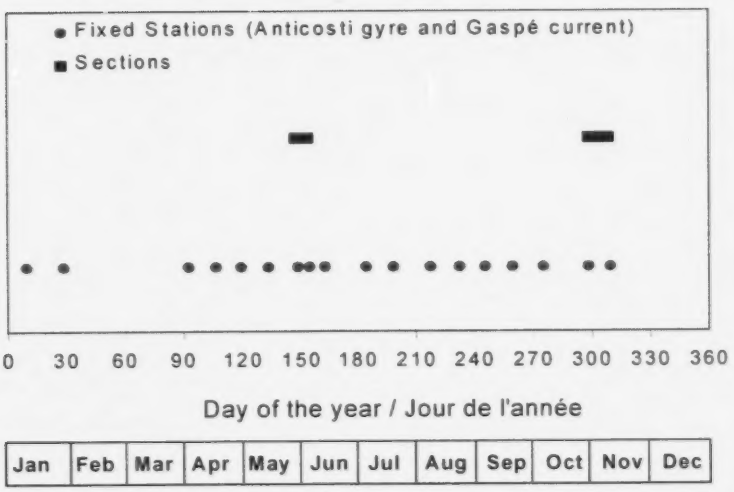

Fixed Stations (Anticosti gyre and Gaspé current)
Sections
0 30 60 90 120 150 180 210 240 270 300 330 360
Day of the year / Jour de l'année
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Figure 1. Dates of 2002 sampling at the Atlantic Zonal Monitoring Program (AZMP) sections (lines) and fixed stations (dots).

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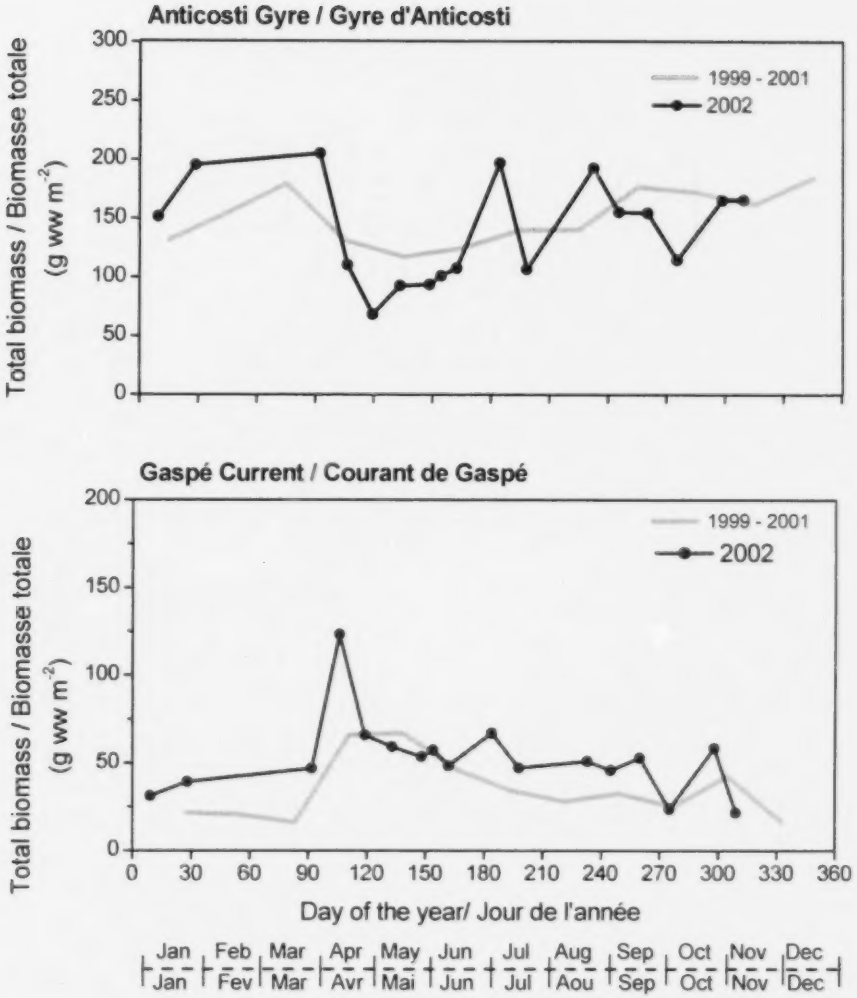

Figure 2. Monthly variations of the total zooplankton biomass in the Anticosti Gyre and the Gaspé Current in 2002. 1999-2001: average value between years for mesozooplankton.

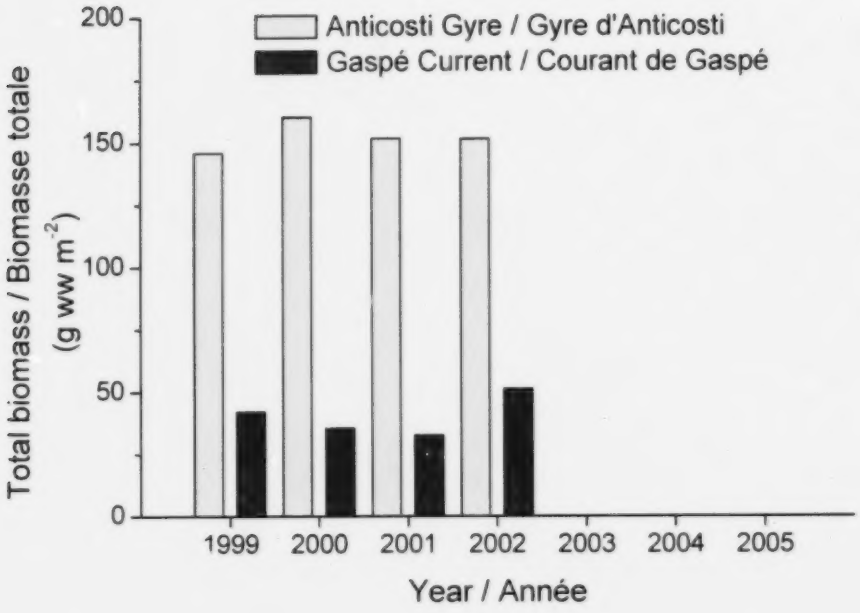

Figure 3. Mean integrated zooplankton biomass in the Anticosti Gyre and the Gaspé Current from 1999 to 2002.

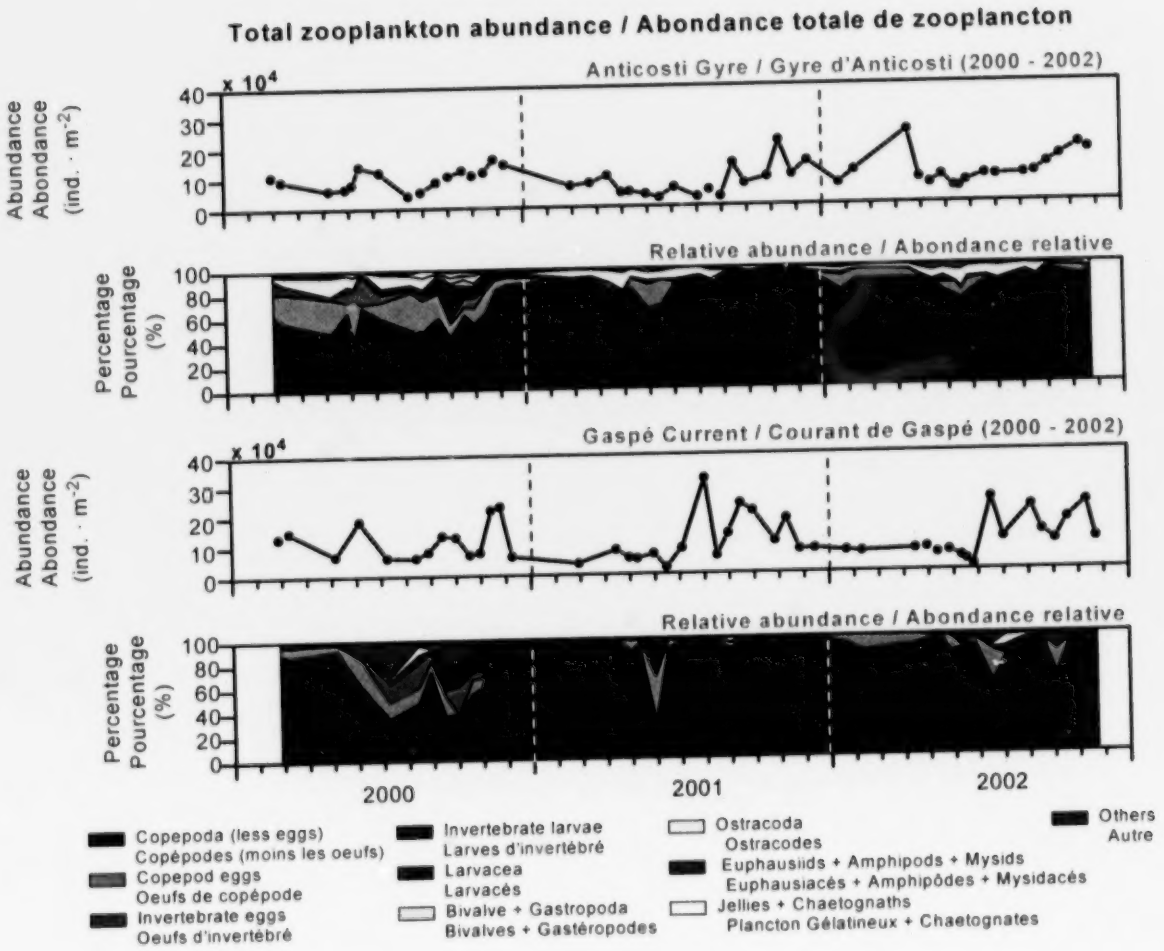

Figure 4. Interannual variations in integrated zooplankton abundance and community structure for the Anticosti Gyre and the Gaspé Current fixed stations from 2000 to 2002.

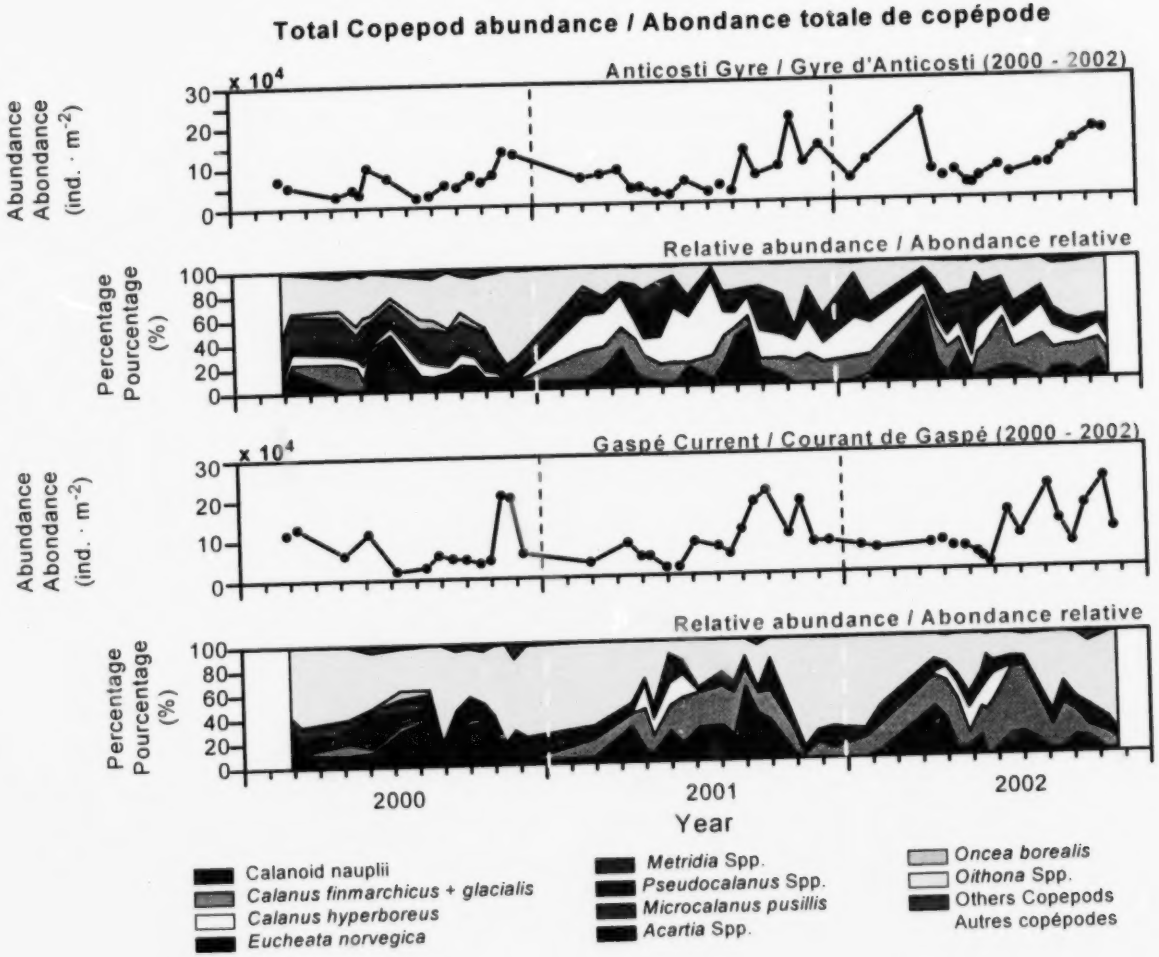

Figure 5. Interannual variations in the integrated copepod abundance and community structure for the Anticosti Gyre and the Gaspé Current fixed stations from 2000 to 2002.

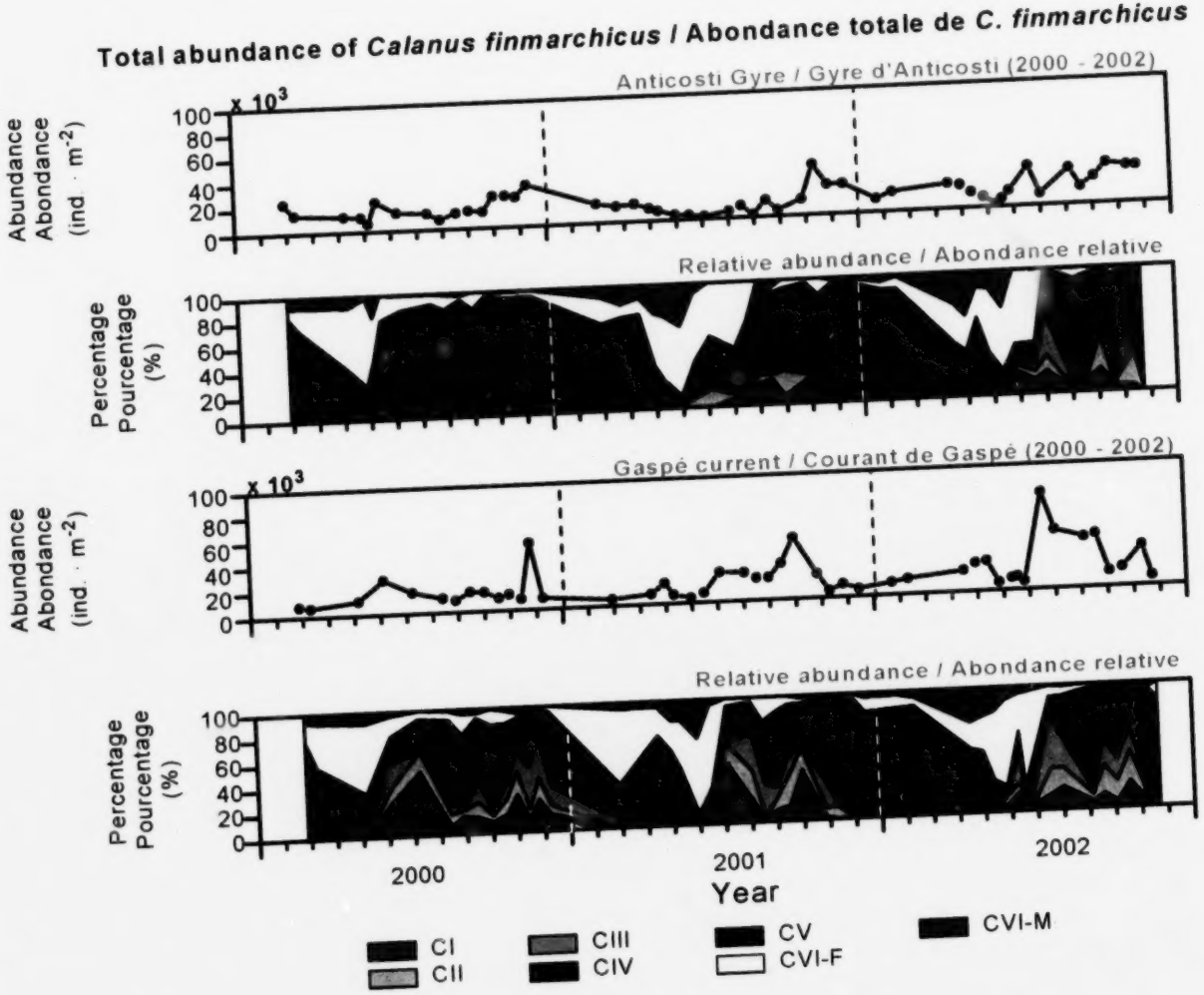

Figure 6. Monthly variations in the depth-integrated abundance of the stage composition of *Calanus finmarchicus* in the Anticosti Gyre and the Gaspé Current in 2002.

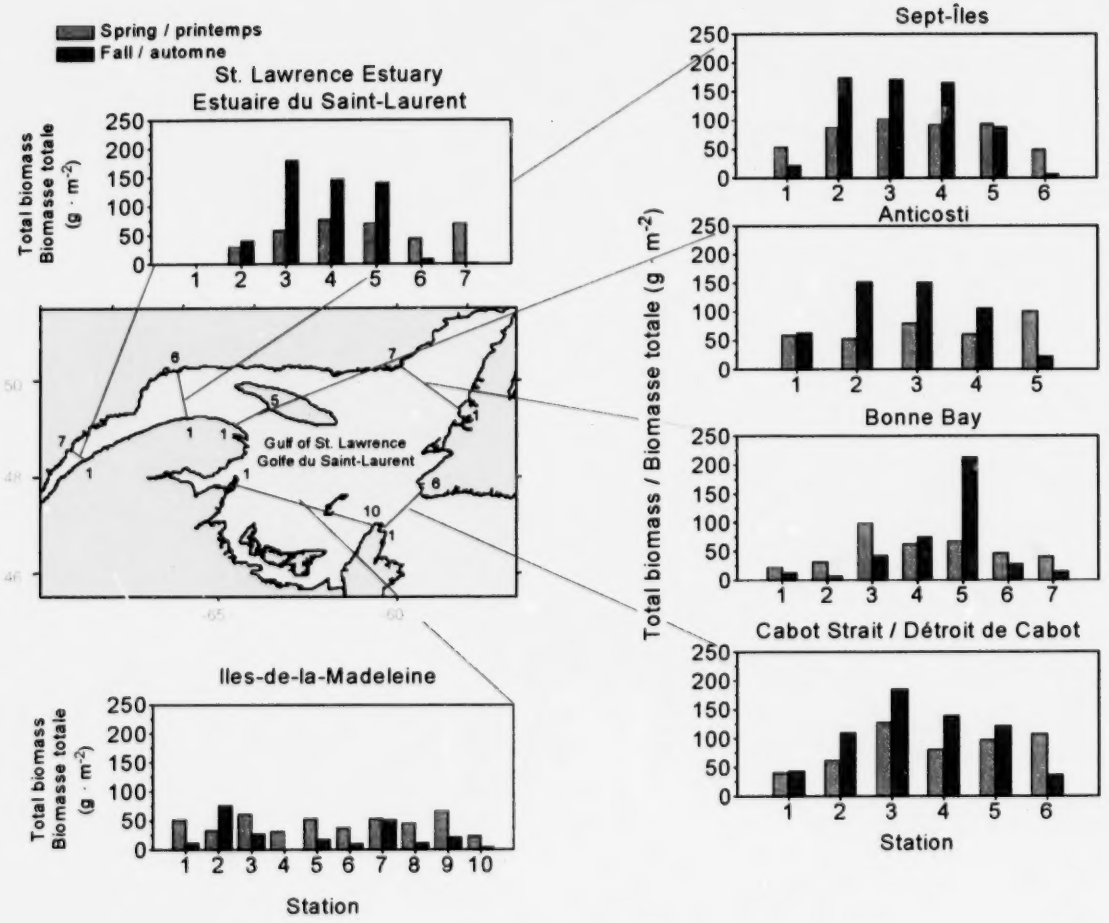

Figure 7. Total zooplankton biomass (wet weight) along the six transects sampled in June and November 2002 in the Lower Estuary and the Gulf of St. Lawrence.

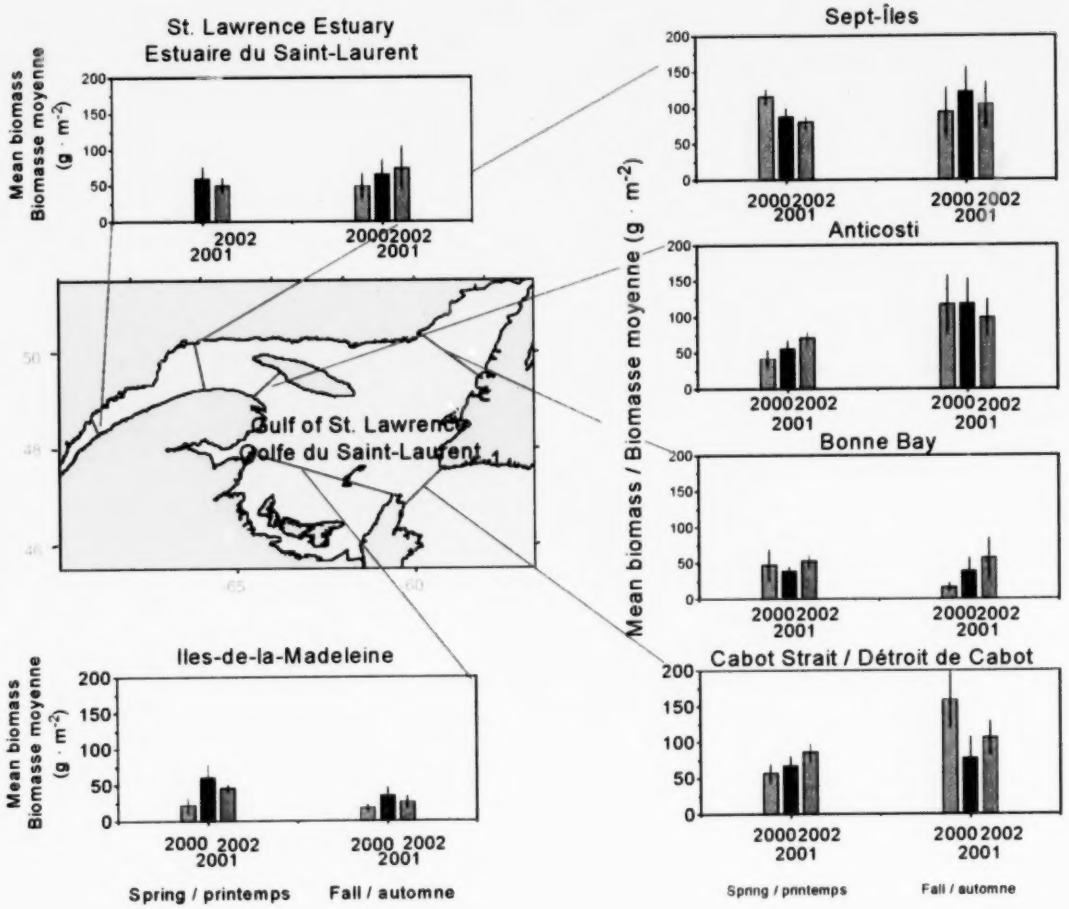

Figure 8. Mean zooplankton biomass (wet weight) along the six transects sampled in June and November 2000-02 in the Lower Estuary and the Gulf of St. Lawrence. The error bars are the standard error.

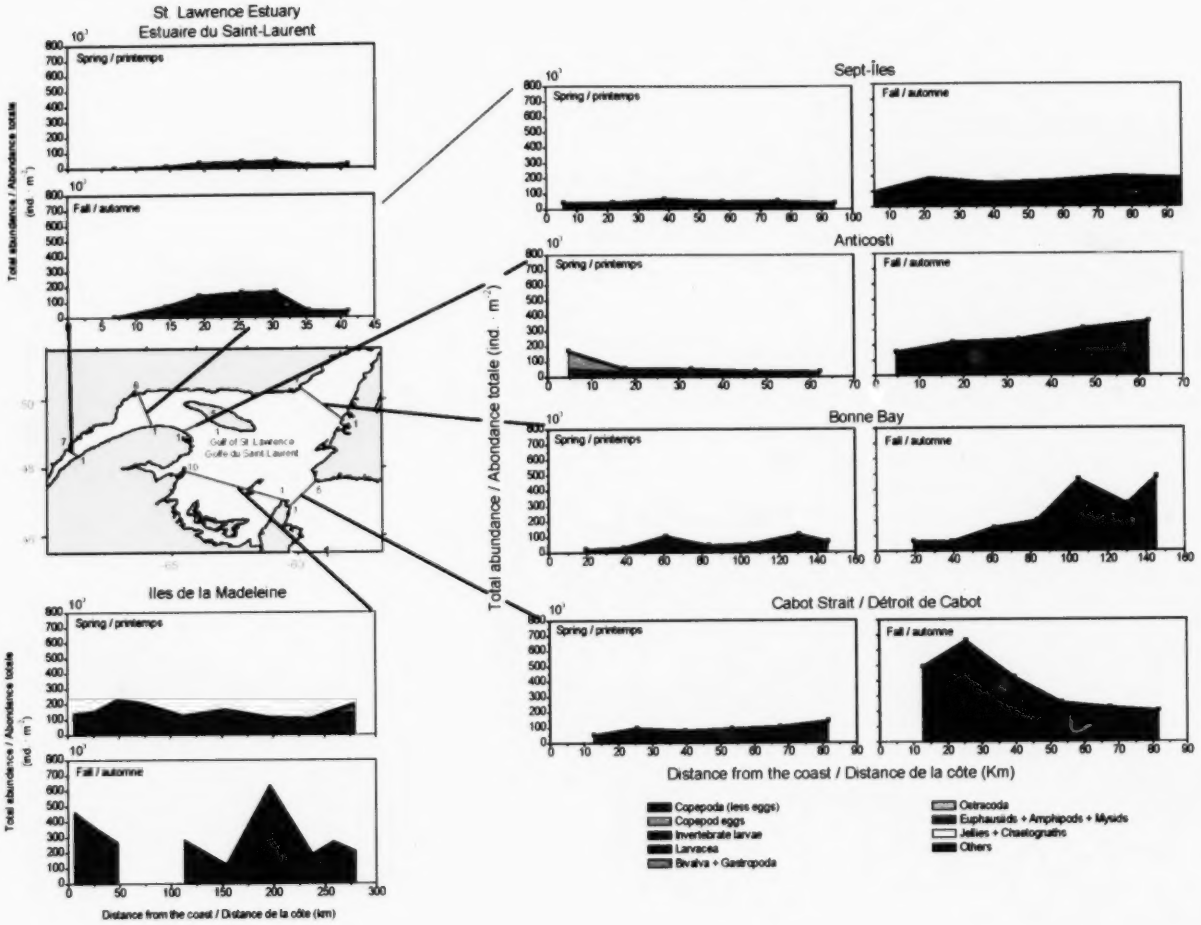

Figure 9. Integrated zooplankton abundance and community structure along the six transects sampled in June and December 2002 in the Lower Estuary and the Gulf of St. Lawrence.

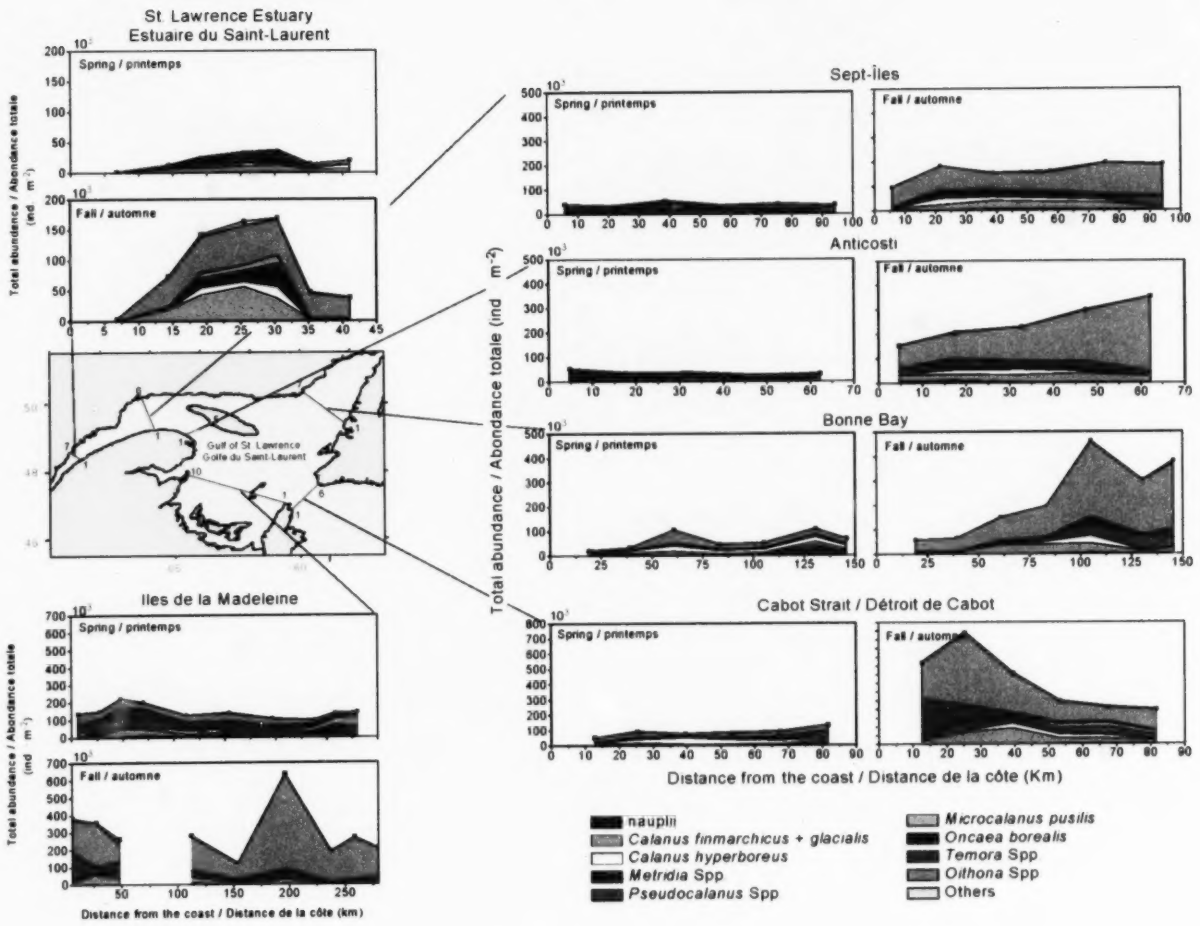

Figure 10. Integrated copepod abundance and community structure along the six transects sampled in June and December 2002 in the Lower Estuary and the Gulf of St. Lawrence.

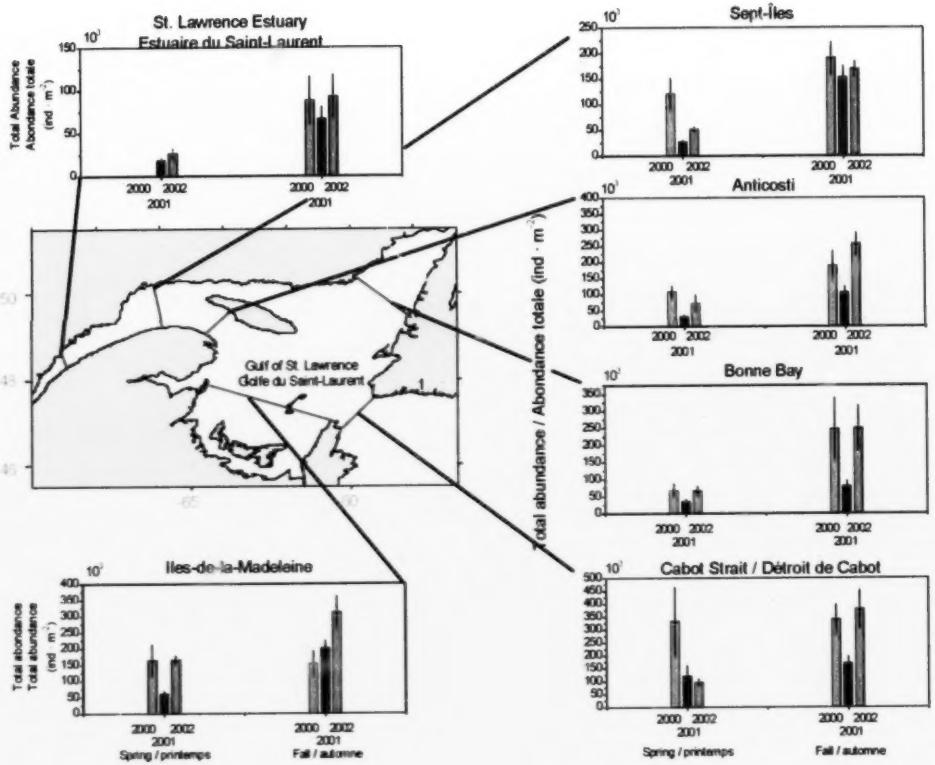

Figure 11. Integrated zooplankton abundance along the six transects sampled in Spring and Fall 2000-02 in the Lower Estuary and the Gulf of St. Lawrence.

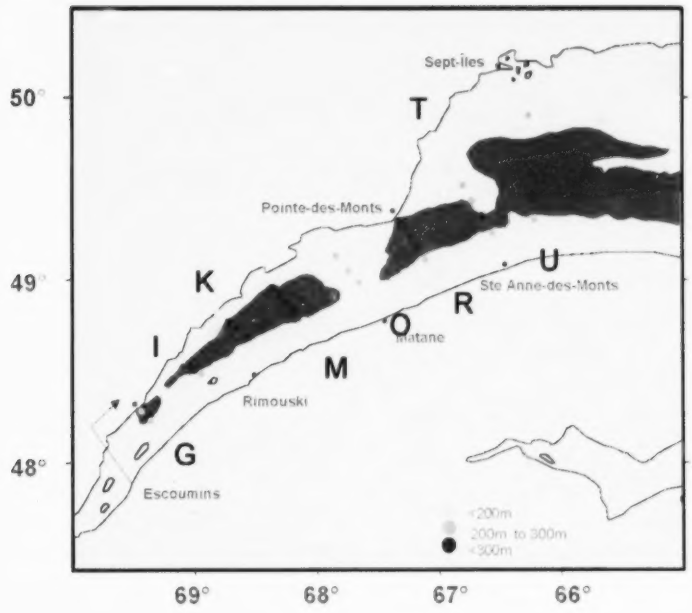

Figure 12. Map showing station locations of annual zooplankton survey in the lower St. Lawrence Estuary and the northwest Gulf of St. Lawrence. Survey takes place in September of each year, since 1994.

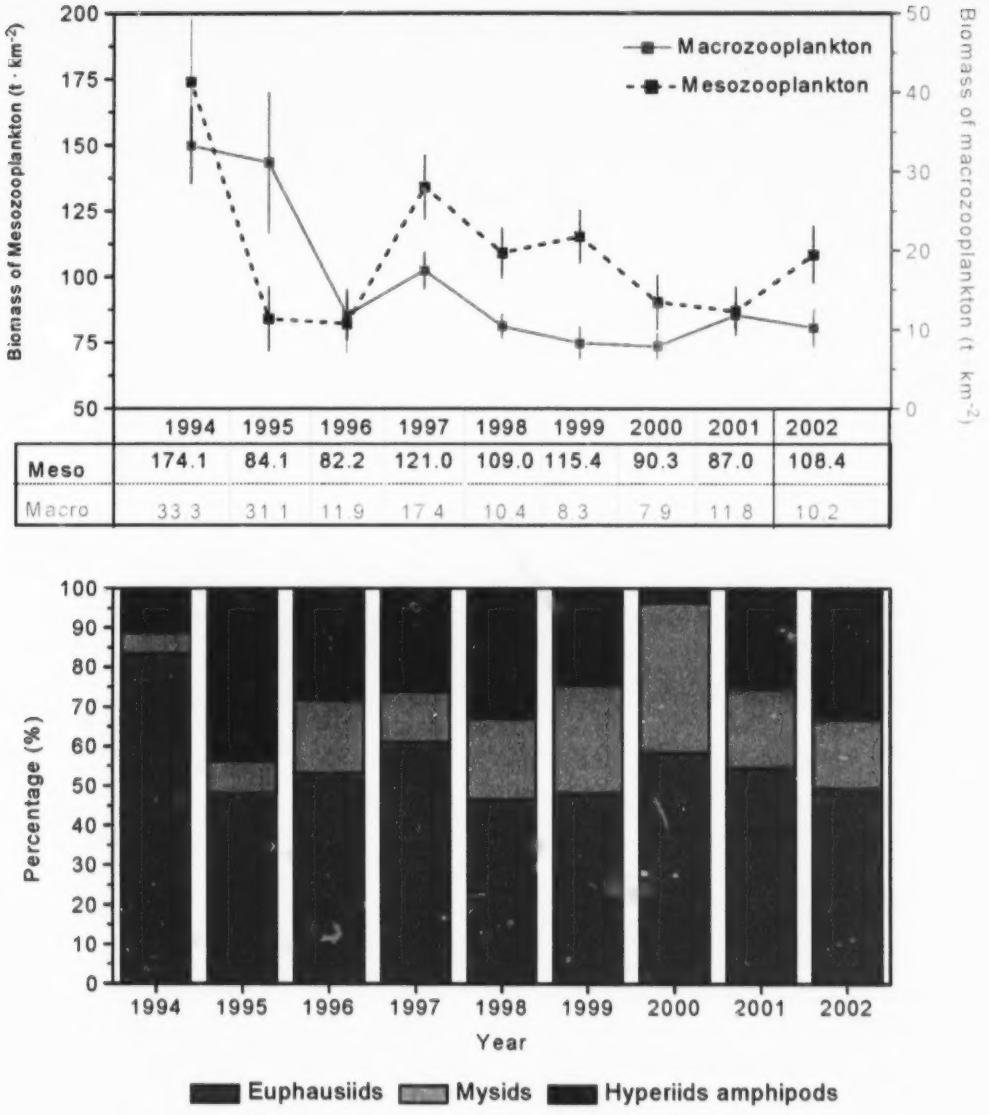

Figure 13. Mean biomass (± SE) of mesozooplankton and macrozooplankton in the Lower St. Lawrence Estuary and the northwest Gulf of St. Lawrence from 1994 to 2001 (upper panel) and relative abundance of the three most important macrozooplankton groups in term of biomass (lower panel).

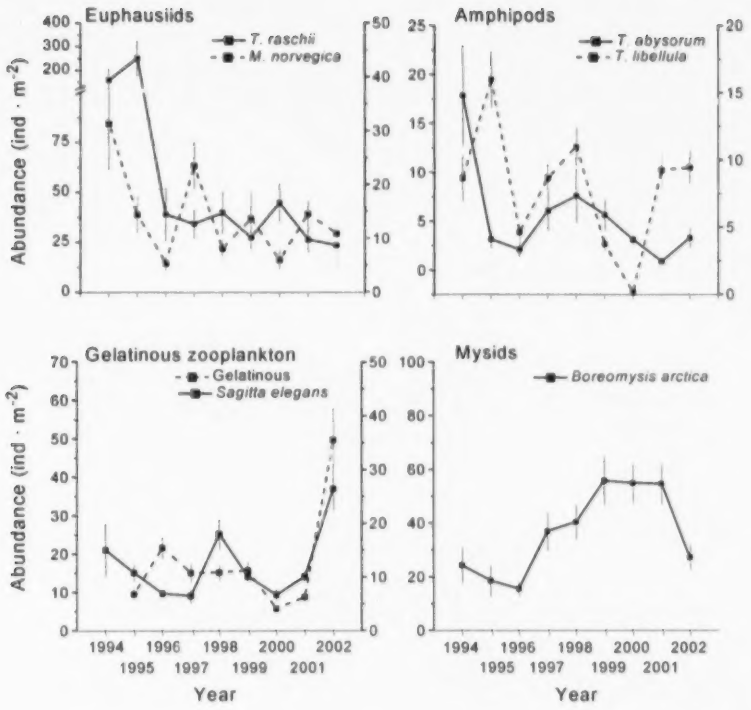

Figure 14. Mean abundance (± SE) of the most important species of macrozooplankton in the Lower St. Lawrence Estuary and the northwest Gulf of St. Lawrence from 1994 to 2002.